

# ARSENIC RETENTION UNDER STATIC AND DYNAMIC FLOW CONDITIONS DURING ACTIVE IRON AND SULFATE REDUCTION

**Author(s):**

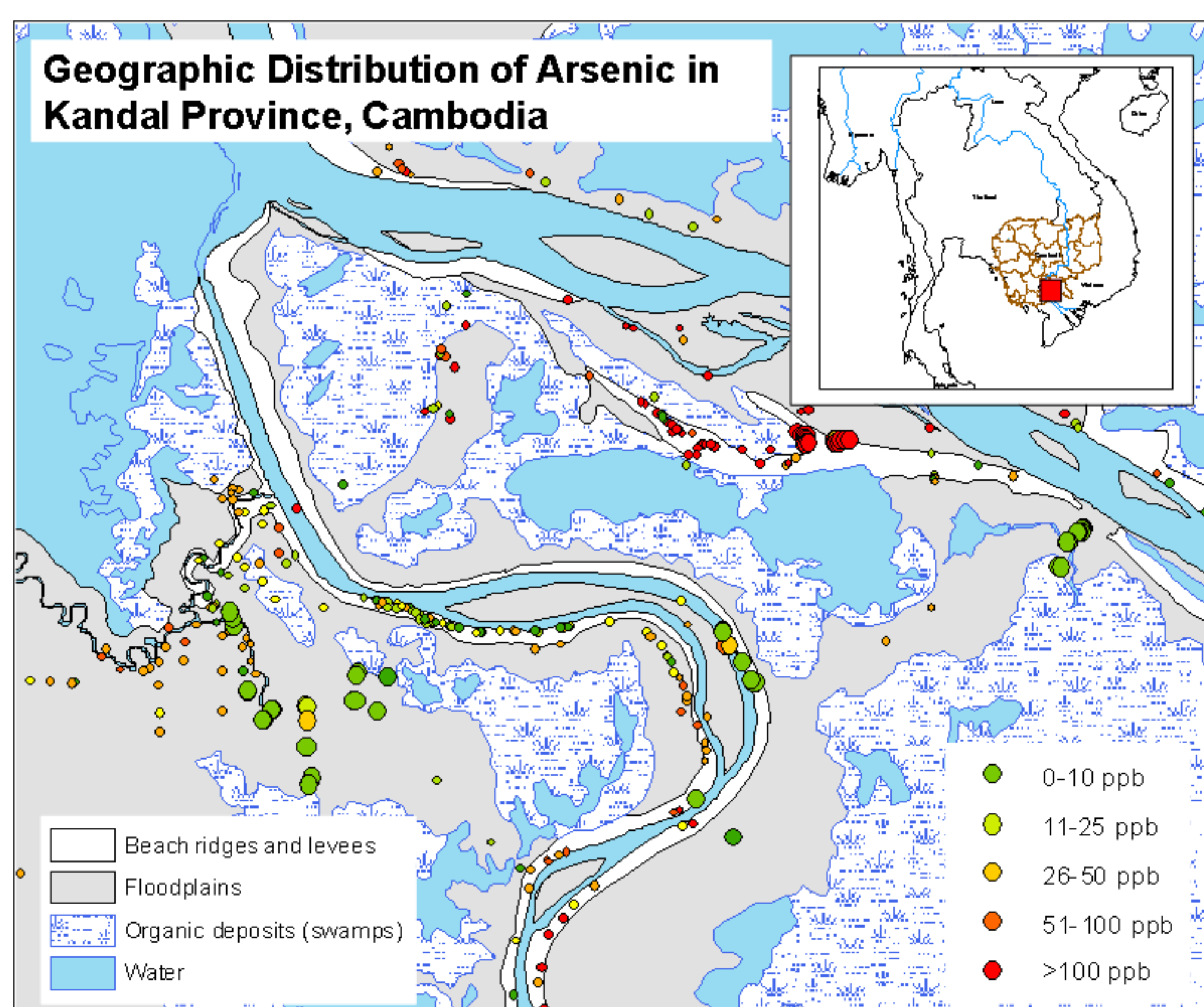
Andrew N. Quicksall, Samantha Saalfeld, Joshua D. Landis, Carl E. Renshaw and Benjamin C. Bostick

**Affiliation(s):**

Dartmouth College, Department of Earth Sciences, Hanover NH 03755

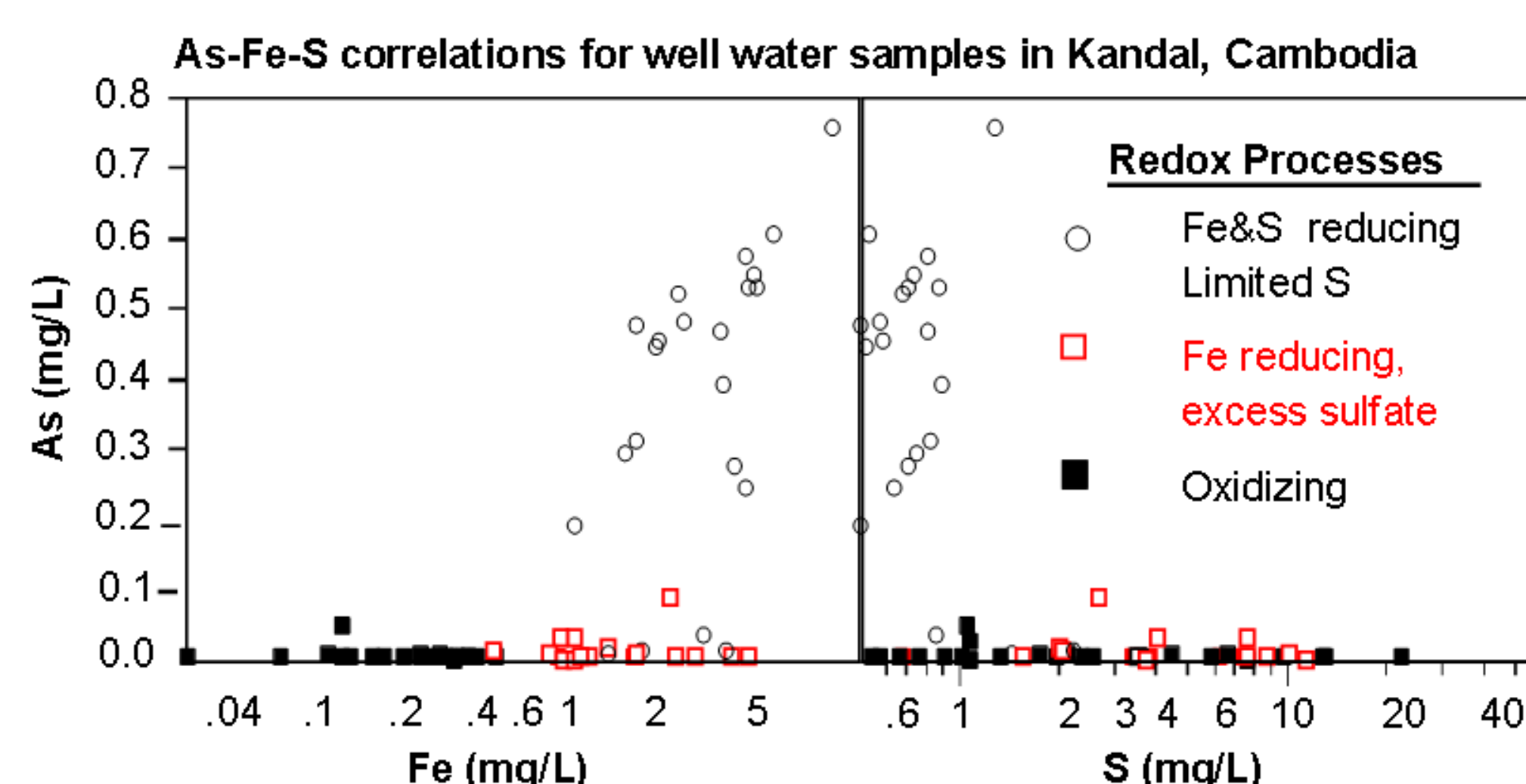
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## INTRODUCTION: FIELD DATA



The geographic distribution of arsenic in the environment is highly variable and a function of active geochemical processes. One important process that influences arsenic concentrations is the reduction of arsenic-bearing iron oxides. When iron oxides are reduced by microbial processes, arsenic and iron should be released into solution together.

Iron dissolution, however, is seldom correlated with high arsenic ground waters (see figure below). A clear relationship between elevated arsenic and low sulfate concentrations suggests that sulfur cycling strongly impacts the fate of arsenic in the environment.

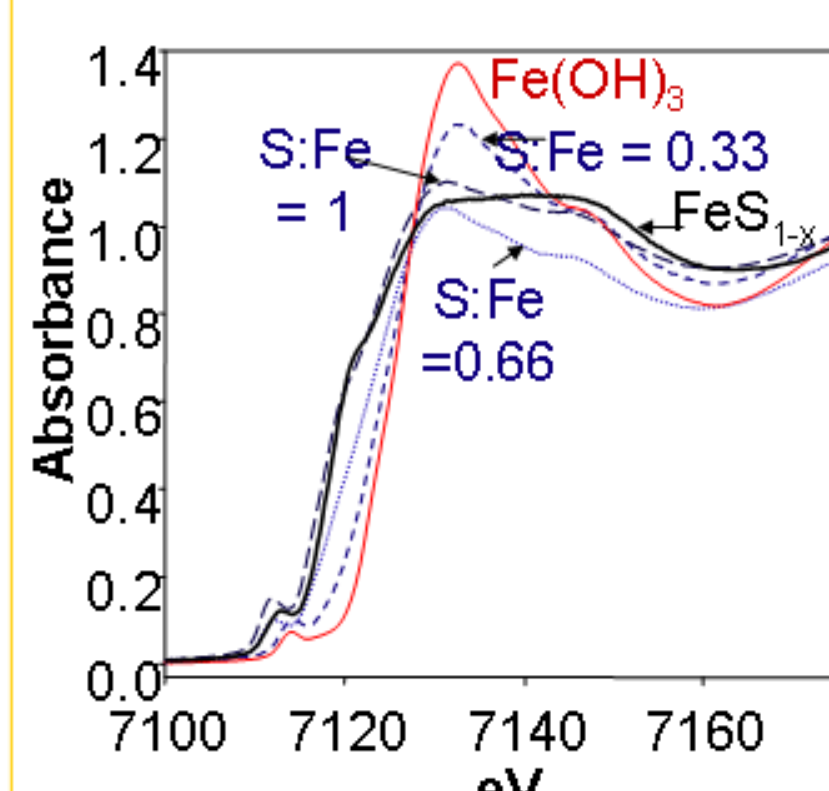


## OBJECTIVE AND METHODS

This research examines the competitive roles of microbially-mediated sulfate and iron reduction on the fate of arsenic and lead in the environment using microcosm experiments of intact soils and model mineral-microbe assemblages under dynamic and static conditions.

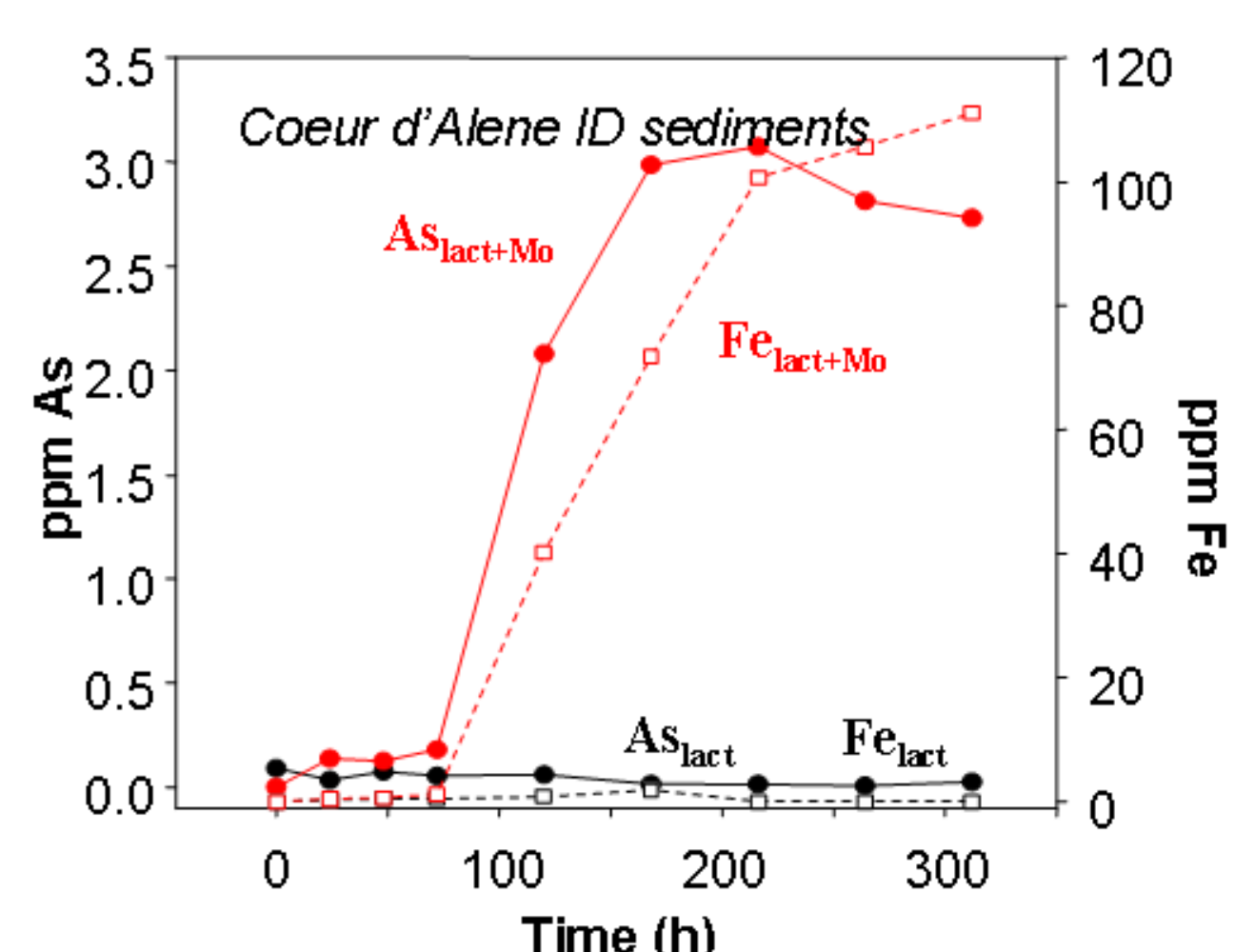
Mineralogical transformations, and the phase associations of As and Pb are monitored using X-ray absorption spectroscopy, which provides a quantitative, *in situ* probe of oxidation state and structure.

XAS spectra showing reduction  $\text{Fe}(\text{OH})_3$  to  $\text{FeS}$  by sulfide (pH 7) as a function of S:Fe added.



## RESULTS: MICROCOSM STUDIES

### SOIL MICROCOSMS: IRON(III) AND SULFATE-REDUCING INCUBATIONS

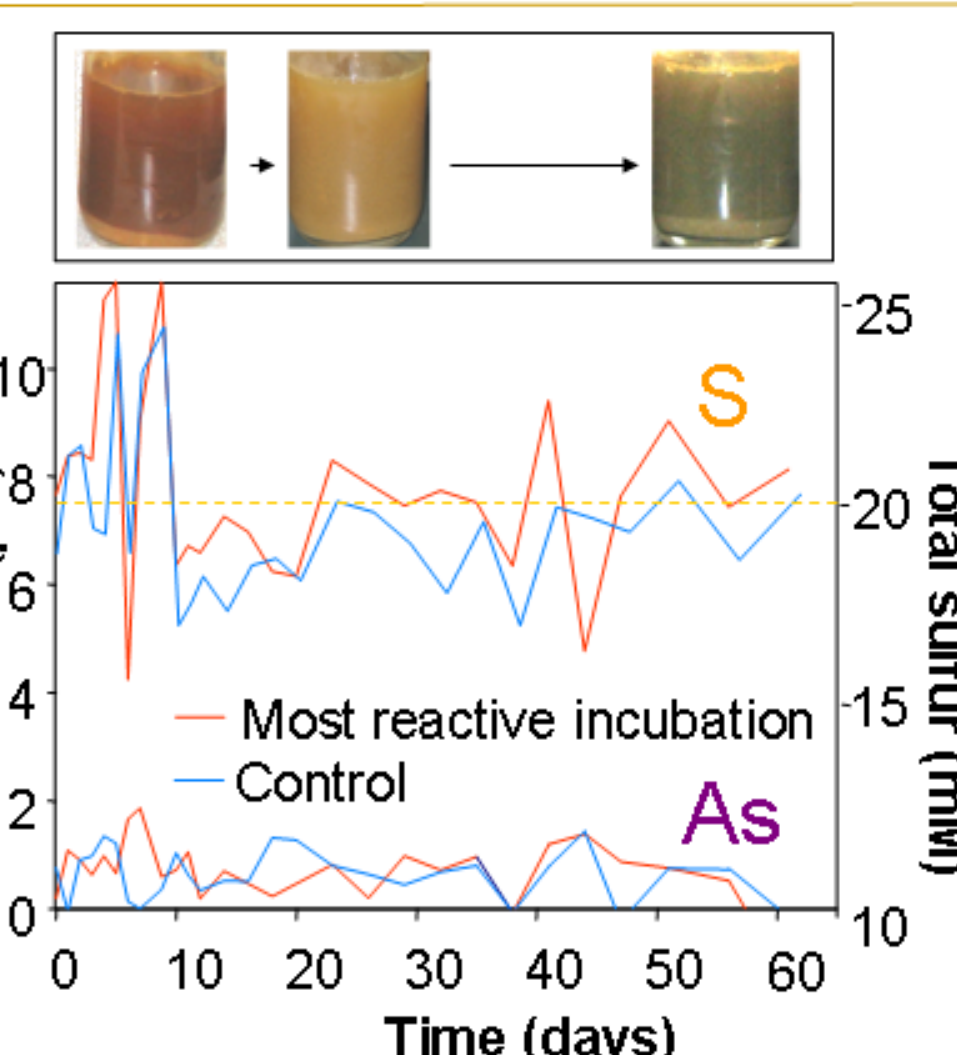


Contaminated sediments from Coeur d'Alene River (ID) were incubated in presence of lactate and/or molybdate to facilitate bacterial reduction. In lactate incubations, Fe and As concentrations were kept low by the formation of mineral sulfides. In contrast, when Mo was also added to suppress sulfate reduction, significant As was released, suggesting that the relative rates of iron and sulfate reduction impact arsenic levels.



### SULFATE-REDUCING INCUBATIONS

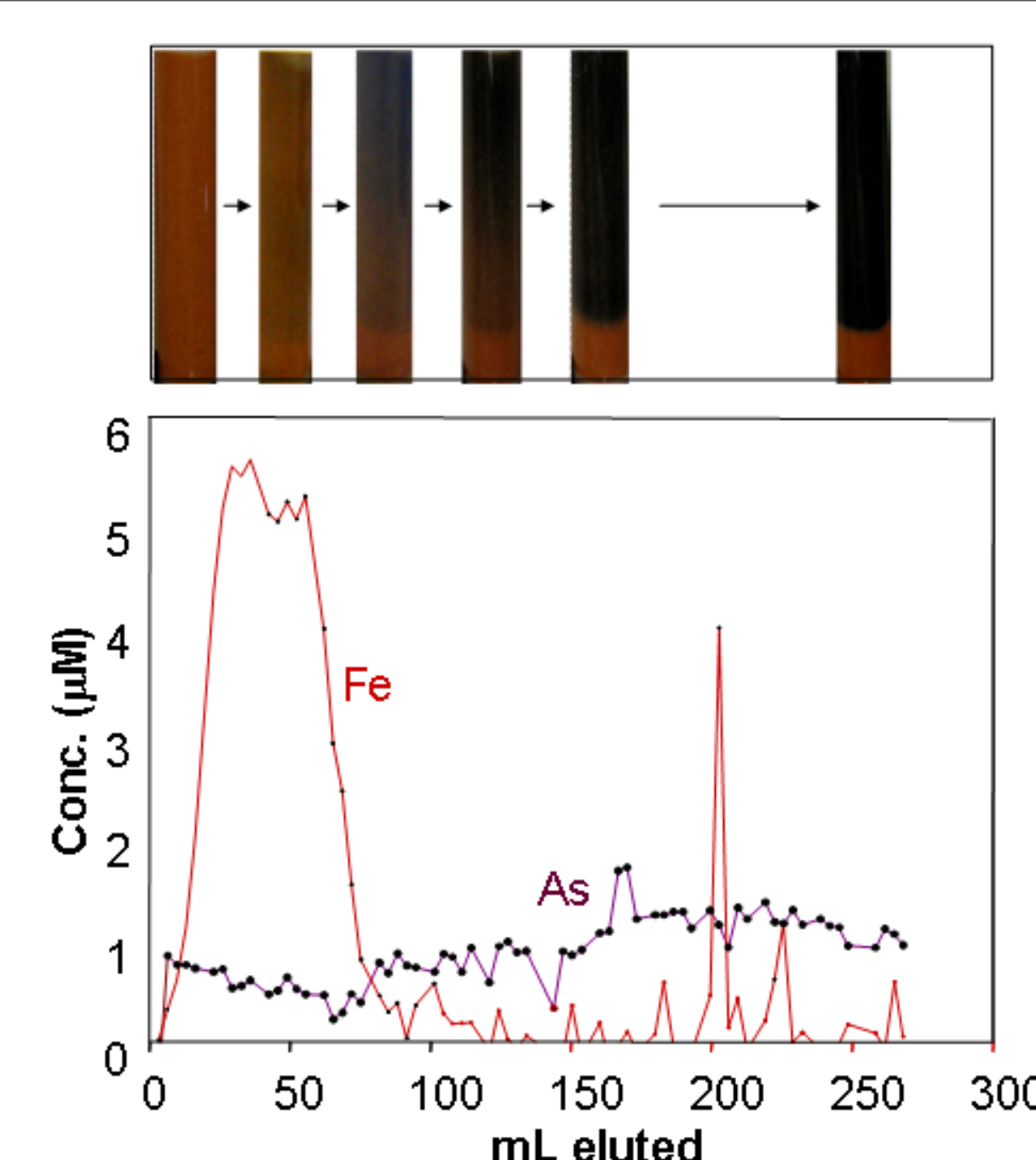
Sulfate reducing bacteria are capable of indirectly reducing iron oxides, possibly releasing arsenic. In batch cultures containing only SRBs, iron oxide (red) reduction to  $\text{FeS}$  was observed (detected using XAS), but no measurable arsenic was released during batch reduction. Thus, indirect iron oxide reduction by microbially-produced sulfide does not appear to release arsenic, possibly by trapping arsenic in insoluble mineral phases.



## RESULTS: COLUMN STUDIES



In column cultures containing SRBs and a sulfate-lactate medium, arsenic was slowly mobilized by sulfate reduction. This mobilization was not accompanied by any appreciable iron release—only 0.02% of the total Fe was released over the course of the experiment while a significant fraction (25%) of As was released. We attribute the loss of arsenic to the limited, slow precipitation of arsenic-free  $\text{FeS}$ , which formed through much of the column. Interestingly, arsenic elution did not contain any obvious peaks, suggesting that it will slowly “leak” from the system as a result of sulfate reduction in the study.



## CONCLUSIONS: CHANGING ENVIRONMENTS

